1746

PATENT
Attorney Docket No. 90065.161701/17732.6310.003

IN THE UNITED STATE PATENT AND TRADEMARK OFFICE

Applicant:	Schuler, et. al	
Serial No.:	10/008,623	Examiner: Markoff, A.
Filed:	06 December 2001	Art Unit: 1746
For:	POTTED TRANSDUCER ARRAY WITH MATCHING NETWORK IN A MULTIPLE PASS CONFIGURATION	

Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22202

TRANSMITTAL OF DECLARATION

Dear Sir:

Further to Applicants' Response to Office Action mailed to the Office on June 24, 2005 and received by the Office on June 27, 2005, Applicants hereby transmit the signed Declaration of Inventor Robert F. Longenberger with the accompanying attachment described therein.

Respectfully submitted,

7/26/2005
Date

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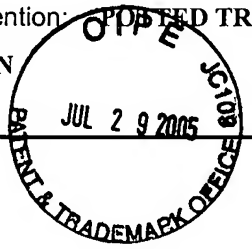
CERTIFICATE OF MAILING BY FIRST CLASS MAIL (37 CFR 1.8) Applicant(s): **Malcolm A. Schuler, et al.**			Docket No. **90065.161701/17732.6310.003**	
Application No. **10/008,623**	Filing Date **December 6, 2003**	Examiner **A. Markoff**	Customer No. **34799**	Group Art Unit **1746**

Invention: **POLED TRANSDUCER ARRAY WITH MATCHING NETWORK IN A MULTIPLE PASS COFIGURATION**



I hereby certify that this **Transmittal Letter for Declaration (1 page)**
(Identify type of correspondence)

is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on July 27 2005.
(Date)

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In The United States Patent & Trademark Office

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DECLARATION UNDER 37 CFR §1.131

1. I/We am an inventor of the subject application.

2. On or before July 22, 1998, I/we conceived and reduced to practice the invention disclosed in the subject applicaiton.

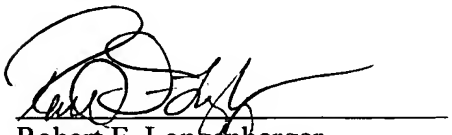
3. Attached to this Declaration is a copy of a portion of a document authored by me/one of the co-inventors. Page 1 of Section 1 describes front to back motion of the wafer across the columns of megasonic waves.

4. I believe that portion of the document corresponds to the subject matter found in claims 13, 14 and 27.

5. The document describes the results of an improved megasonic cleaning apparatus.

6. The apparatus was made and tested before June 2, 1997.

7. All statements made herein of my own knowledge are true, all statements made herein on information and belief are believed to be true, and these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.



Robert F. Longenberger

Attachment #1

IMPROVEMENTS TO THE MEGASONIC CLEANING OF SILICON WAFERS

Robert F. Longenberger

Harris Semiconductor

Mountaintop, Pennsylvania 18707

PREFACE

This project has been conducted with a considerable amount of assistance from many coworkers. A special acknowledgment to the members of the Clean Team, Mike Caravaggio, Tom Grebbs, Rick McEntee, Malcolm Schuler, Frank Stensney, and Ray Webb, who were very instrumental in performing process analyses, presenting the challenges to the project, making suggestions, providing the innovative component designs, running the particle tests, developing the graphics, and overall support. A very special thanks to the Unique Solutions team who fabricated most of the components and the final assembly of the Clean Bench. A special thanks to Larry Weldon of Blatek Incorporated for assistance in the new transducer development, George White of Lehighton Electronics for making the fabrication of the power generators possible, and also to Alfred Mayer, the father of Megasonic cleaning systems, for his guidance through his original work.

ABSTRACT

The principle objective of this project was to improve the cleaning ability of the wet benches used in the fabrication of semiconductor devices and to reduce the number of defects caused by particulate contamination. The end result of this cleaning improvement is to enhance the yield of the finished products which will reduce the overall manufacturing cost of the devices.

After the initial cleaning ability of the wet benches was determined, a series of improvements were introduced. First a newly designed transducer was integrated and tested for performance. Pulsing the RF excitation gave a marked improvement to the cleaning ability without exceeding the average power delivered to the transducer. The original tank design was then examined and a suitable design had been fabricated with a considerably reduced footprint and with an ability to be adapted to robotic systems. Tantalum covered the face of the original transducer. The new design totally eliminated the presence of metal on the tank. Rinsing then had to be addressed. Previous tanks used a hot or cold overflow and some were quick dump rinse. Quick dump rinse was one of the most effective rinse techniques but still did little for particle removal. A "drop-in" Megasonic transducer assembly was designed to aid in the removal of particles. Cleaning had reached a new high but the excitation of the transducer was still an issue. The original RF source had servere limitations of power and frequency. Searches for a better amplifier proved fruitless due to reliability issues and a power generator had to be developed. A total class D (digital) generator with a phase locked loop frequency control was designed and built.

The new system design had several immediate paybacks. The cost of the new transducers was one fourth of the original ones and the newly designed power generators cost less than half of the initial model. Generator reliability issues became non existent. The new transducer has a nearly perfect impedance match to the generator so energy transfer is extremely efficient and the new generator uses less than half the power of the original system. Wafer particle removal in excess of 97% was now possible with an improvement in probe yield being immediately evident. Cleaning has reached world class with these developments.

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LIST OF ILLUSTRATIONS

SECTION I

INTRODUCTION

The improvement of the cleaning of silicon wafers used in the manufacturing of semiconductors has been a continuing effort at the Harris Semiconductor facility located in Mountaintop, Pennsylvania, since the earliest days of its operation. The initial experiments for Megasonic cleaning in a manufacturing environment were conducted at the Mountaintop plant during the time when it was part of the RCA Solid State Division with the laboratory tests being run in the Somerville operations in the 1970s[1]. The original work was conducted to provide a very clean substrate for the manufacturing of flat plate photovoltaic solar cell arrays. The results of the initial work by Mayer and Shwartzman were excellent and Megasonic cleaning became an integral part of the bulk of wafer fabrication at the Mountaintop plant. The systems used were manufactured by Fluorocarbon (now Verteq), a licensee of the original patent, and performed adequately but as experience was gained it was apparent that the basic system could be improved.

A series of experiments were conducted to eliminate the presence of the metals in the bath, particularly the tantalum foil surface of the original megasonic transducer, in addition to improving the cleaning efficiency of the wet bench in general. In doing these tests it was also determined that an alternative to the function generator/ power amplifier pair was needed. The results of this work done by the Mountaintop Clean Team has brought the Megasonic cleaning to a new level with some added benefits, specifically:

(1) A smaller footprint of the SC1 (ammonium hydroxide and hydrogen peroxide, $NH_4OH+H_2O_2$) bath since the wafer carriers are moved front to back to front rather than left to right. This allows loading and unloading from a common point making the use of robotic control more feasible.

(2) The motion of the carrier in a front to back to front transition gives an double pass over the transducers and a double cleaning for the same insertion.

(3) Transducers have been redesigned with either a face of PVDF (polyvinalidene fluoride, Kynar® trademark of DuPont) or 5/4λ quartz. Elimination of metal contaminants in the bath is the result.

(4) A recirculating filter system for the SC1 to remove the suspended particles from the bath was added. A reduction in the reattachment of particles onto the wafers is realized after the process is completed.

(5) The use of analog function generators have inherent drift and poor accuracy, a phase locked loop gerlerator on the other hand has the